

# Lecture Notes in Computer Science

762

Edited by G. Goos and J. Hartmanis

Advisory Board: W. Brauer D. Gries J. Stoer



K. W. Ng P. Raghavan  
N. V. Balasubramanian F.Y. L. Chin (Eds.)

# Algorithms and Computation

4th International Symposium, ISAAC '93  
Hong Kong, December 15-17, 1993  
Proceedings

**Springer-Verlag**

Berlin Heidelberg New York  
London Paris Tokyo  
Hong Kong Barcelona  
Budapest

## Series Editors

Gerhard Goos  
Universität Karlsruhe  
Postfach 69 80  
Vincenz-Priessnitz-Straße 1  
D-76131 Karlsruhe, Germany

Juris Hartmanis  
Cornell University  
Department of Computer Science  
4130 Upson Hall  
Ithaca, NY 14853, USA

## Volume Editors

K. W. Ng  
Department of Computer Science, The Chinese University of Hong Kong  
Hong Kong

P. Raghavan  
IBM T. J. Watson Research Center  
Box 218, Yorktown Heights, NY 10598, USA

N. V. Balasubramanian  
Department of Computer Science, City Polytechnic of Hong Kong  
Hong Kong

F. Y. L. Chin  
Department of Computer Science, The University of Hong Kong  
Hong Kong

CR Subject Classification (1991): F.1-2, G.2-3, H.3, I.3.5

ISBN 3-540-57568-5 Springer-Verlag Berlin Heidelberg New York  
ISBN 0-387-57568-5 Springer-Verlag New York Berlin Heidelberg

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

© Springer-Verlag Berlin Heidelberg 1993  
Printed in Germany

Typesetting: Camera-ready by author  
Printing and binding: Druckhaus Beltz, Hemsbach/Bergstr.  
45/3140-543210 - Printed on acid-free paper

## Preface

The first International Symposium on Algorithms was held in Tokyo in 1990 and the second one in Taipei in 1991. The title was changed to International Symposium on Algorithms and Computation in 1992 when it was held in Nagoya. The papers in this volume were presented at the fourth symposium in Hong Kong during December 15-17, 1993. The job of the Program Committee was quite challenging in that it had to sieve nearly 200 papers! The international nature of the symposium is apparent not only from the composition of the Program Committee but also in the number of countries represented in the papers received (some 26). We are grateful to all those who submitted papers for consideration and to the Program Committee members who helped in the evaluation of these many papers. Three eminent invited speakers, Prof. Allan Borodin of the University of Toronto, Prof. Tom Leighton of MIT, and Dr. Mihalis Yannakakis of AT&T, have contributed to these proceedings. We are grateful to them. We hope that the international research community will benefit significantly from these proceedings and we are grateful to Springer-Verlag for undertaking to publish them. We are grateful to several sponsors who made this symposium financially viable, and to the IEEE Computer Society for cooperation.

We, the Organizing Committee, the Program Committee Co-chairs, and the Symposium Co-chairs, have worked hard to provide for a quality symposium and quality proceedings. The selected papers were chosen on the basis of originality and relevance to the field of algorithms and computation. The selections were based on extended abstracts, which represent a preliminary report of ongoing research. It is anticipated that many of these reports will appear in more polished and complete form in recognized scientific journals.

N V Balasubramanian  
Kam Wing Ng

Francis Y.L. Chin  
Prabhakar Raghavan

December 1993

**Symposium Chairs:**

N.V. Balasubramanian (City Polytechnic of Hong Kong, HK)

Francis Y.L. Chin (The University of Hong Kong, HK)

**Program Committee Chairs:**

Kam Wing Ng (Chinese University of HK, HK)

Prabhakar Raghavan (IBM, USA)

**Organising Committee Members:**

Siu Wing Cheng (Hong Kong University of Science and Technology, HK)

Horace Ip (City Polytechnic of Hong Kong, HK)

Tak Wah Lam (The University of Hong Kong, HK)

Karl Leung (Hong Kong Polytechnic, HK)

K.F. Suen (Hong Kong Baptist College, HK)

**Advisory Committee Members:**

Francis Y.L. Chin (The University of Hong Kong, HK)

W.L. Hsu (Academia Sinica, R.O.C.)

T. Ibaraki (Kyoto University, Japan)

D.T. Lee (Northwestern University, USA)

R.C.T. Lee (Tsing Hua University, R.O.C.)

T. Nishizeki (Chair, Tohoku University, Japan)

**Program Committee Members:**

Pranay Chaudhury, UNSW, Australia

Ding-Zhu Du, U. of Minnesota, USA

Wen-Lian Hsu, Academia Sinica, Taiwan

Hiroshi Imai, U. of Tokyo, Japan

Maria Klawe, U. of British Columbia, Canada

Rao Kosaraju, Johns Hopkins University, USA

R.C.T. Lee, Tsing Hua University, Taiwan

J. van Leeuwen, U. of Utrecht, The Netherlands

Christos Papadimitriou, UC San Diego, USA

Martin Tompa, U. of Washington, USA

Eli Upfal, IBM, USA

Osamu Watanabe, TITech, Japan

In Cooperation with  
IEEE Computer Society

## Acknowledgements

The ISAAC '93 Program Committee thanks the following people for their help in evaluating the submissions:

Pankaj Agarwal, Alok Aggarwal, Paul Callahan, S.W. Cheng, Ron Fagin, Mike Goodrich, Joe Halpern, Susumu Hayashi, Keiko Imai, Russell Impagliazzo, Amos Israeli, Anna Karlin, Hoong-Chuin Lau, Rajeev Motwani, Ketan Mulmuley, Nick Pippenger, Balaji Raghavachari, V.T. Rajan, Baruch Schieber, Madhu Sudan, H.F. Ting, Seinosuke Toda, Takeshi Tokuyama and Gilbert Young.

The Organizing Committee thanks:

- (i) Miss Monica Lau, Secretary to Dr N V Balasubramanian, for all the assistance rendered to him in his correspondence with the donors, Hong Kong Tourist Association, IEEE Computer Society, etc. Monica was also secretary to the Organizing Committee and handled its correspondence, scheduling of meetings, taking minutes, follow-up, sending and receiving faxes, answering telephone calls etc. Her patience, promptness and courtesy has made the organizing work effective and pleasant.
- (ii) Miss Maria Lam, Secretary to Professor Francis Chin, for typing the list of accepted papers, helping with the accommodation of PC members, helping with the camera-ready papers, registration, etc.
- (iii) Ms Nancy Donovan of the IBM, T J Watson Research Centre, Yorktown Heights, New York for her help in receiving, sorting and distributing submissions to the conference.
- (iv) Miss Doris Lam of the Hong Kong Tourist Association for all the assistance, information and the colourful stationery provided by her with keen interest and enthusiasm.

ISAAC '93 was supported by:

The Croucher Foundation  
Epson Foundation  
Hong Kong Computer Society  
Lee Hysan Foundation  
IEEE Society HK Section Computer Chapter  
The Hong Kong Chapter of ACM  
SIGAL, IPSJ (Japan)  
TGCOMP, IEICE (Japan)  
The University of Hong Kong  
The Chinese University of Hong Kong  
Hong Kong University of Science & Technology  
Hong Kong Polytechnic  
City Polytechnic of Hong Kong  
Hong Kong Baptist College

## **Best Paper Award**

The Best Paper Award this year is awarded in recognition of the most outstanding paper written solely by a student, as judged by the program committee, and is presented for the paper, “Multicommodity Flows in Even, Planar Networks,” by Karsten Weihe.

# Contents

## SESSION 1A

|  |    |
|--|----|
| Reaching a Goal with Directional Uncertainty<br><i>Mark de Berg, Leonidas Guibas, Dan Halperin, Mark Overmars,<br/>Otfried Schwarzkopf, Micha Sharir, and Monique Teillaud</i> ..... | 1  |
| Constructing Degree-3 Spanners with Other Sparseness Properties<br><i>Gautam Das and Paul J. Heffernan</i> .....   | 11 |
| Remembering Conflicts in History Yields Dynamic Algorithms<br><i>Katrin Dobrindt and Mariette Yvinec</i> .....   | 21 |

## SESSION 1B

|   |    |
|---|----|
| Coloring Random Graphs in Polynomial Expected Time<br><i>Martin Furer, C.R. Subramanian, and C.E. Veni Madhavan</i> ..... | 31 |
| Graphical Degree Sequence Problems with Connectivity Requirements<br><i>Takao Asano</i> .....                             | 38 |
| How to Treat Delete Requests in Semi-Online Problems<br><i>Yang Dai, Hiroshi Imai, Kazuo Iwano, and Naoki Katoh</i> ..... | 48 |

## SESSION 2A

|  |    |
|--|----|
| Finding the Shortest Watchman Route in a Simple Polygon<br><i>Svante Carlsson, Håkan Jonsson, and Bengt J. Nilsson</i> ..... | 58 |
| Constructing Shortest Watchman Routes by Divide-and-Conquer<br><i>Xuehou Tan and Tomio Hirata</i> .....                      | 68 |
| A Graph Coloring Result and Its Consequences for Some Guarding Problems<br><i>Frank Hoffmann and Klaus Kriegel</i> .....     | 78 |

## SESSION 2B

|  |     |
|--|-----|
| The Maximum k-Dependent and f-Dependent Set Problem<br><i>Anders Dessmark, Klaus Jansen, and Andrzej Lingas</i> .....                  | 88  |
| Finding Shortest Non-Crossing Rectilinear Paths in Plane Regions<br><i>Jun-ya Takahashi, Hitoshi Suzuki, and Takao Nishizeki</i> ..... | 98  |
| Treewidth of Circle Graphs<br><i>T. Kloks</i> .....  | 108 |

## SESSION 3A

|   |     |
|---|-----|
| A Framework for Constructing Heap-like Structures In-Place<br><i>Jingsen Chen</i> ..... | 118 |
|---|-----|



|  |     |
|--|-----|
| Double-Ended Binomial Queues<br><i>C.M. Khoong and H.W. Leong</i> .....  | 128 |
| A Simple Balanced Search Tree with $O(1)$ Worst-Case Update Time<br><i>Rudolf Fleischer</i> .....  | 138 |
| <b>SESSION 3B</b>  |     |
| Mapping Dynamic Data and Algorithm Structures into Product Networks<br><i>Sabine R. Öhring and Sajal K. Das</i> .....                      | 147 |
| Permutation Routing on Reconfigurable Meshes<br><i>J.C. Cogolludo and S. Rajasekaran</i> .....   | 157 |
| Adaptive and Oblivious Algorithms for D-Cube Permutation Routing<br><i>Miltos D. Grammatikakis, D. Frank Hsu, and Frank K. Hwang</i> ..... | 167 |
| <b>SESSION 4A</b>  |     |
| On Quadratic Lattice Approximations<br><i>Anand Srivastav and Peter Stangier</i> .....   | 176 |
| A 2/3-Approximation of the Matroid Matching Problem<br><i>Toshihiro Fujito</i> .....   | 185 |
| <b>SESSION 4B</b>  |     |
| Using Fractal Geometry for Solving Divide-and-Conquer Recurrences<br><i>Simant Dube</i> .....  | 191 |
| Simple Combinatorial Gray Codes Constructed by Reversing Sublists<br><i>Frank Ruskey</i> .....   | 201 |
| <b>SESSION 5     Invited Paper</b>   |     |
| Time-Space Tradeoffs<br><i>Allan Borodin</i> .....   | 209 |
| <b>SESSION 6A</b>  |     |
| Separating Exponentially Ambiguous NFA from Polynomially Ambiguous NFA<br><i>Hing Leung</i> .....  | 221 |
| Threshold Computation and Cryptographic Security<br><i>Yenjo Han, Lane A. Hemaspaandra, and Thomas Thierauf</i> .....                      | 230 |
| On the Power of Reading and Writing Simultaneously in Parallel Computations<br><i>Rolf Niedermeier and Peter Rossmanith</i> .....          | 240 |
| Relativizing Complexity Classes with Random Oracles<br><i>Ronald V. Book</i> .....   | 250 |

## SESSION 6B

|   |     |
|---|-----|
| Perpetual Gossiping<br><i>Arthur L. Liestman and Dana Richards</i> .....  | 259 |
| A Probabilistic Selection Network with Butterfly Networks<br><i>Takahiro Ikeda</i> .....  | 267 |
| Optimal Group Gossiping in Hypercubes Under Wormhole Routing Model<br><i>Satoshi Fujita, Masafumi Yamashita, and Tadashi Ae</i> ..... | 277 |
| Optimal Linear Broadcast Routing with Capacity Limitations<br><i>S. Bitan and S. Zaks</i> .....                                       | 287 |

## SESSION 7 Invited Paper

|  |     |
|--|-----|
| A Survey of Recent Advances in Multicommodity Flow: Algorithms and Applications<br><i>Baruch Awerbuch and Tom Leighton</i> ..... | 297 |
|--|-----|

## SESSION 8A

|   |     |
|---|-----|
| Parallel Construction of Canonical Ordering and Convex Drawing of Triconnected Planar Graphs<br><i>Xin He and Ming-Yang Kao</i> ..... | 303 |
| Number Theory Helps Line Detection in Digital Images<br><i>Tetsuo Asano and Naoki Katoh</i> .....                                     | 313 |
| Optimally Computing the Shortest Weakly Visible Subedge of a Simple Polygon<br><i>Danny Z. Chen</i> .....                             | 323 |

## SESSION 8B

|  |     |
|--|-----|
| Multicommodity Flows in Even, Planar Networks<br><i>Karsten Weihe</i> .....  | 333 |
| Linear Time Algorithms for Disjoint Two-Face Paths<br><i>Heike Ripphausen-Lipa, Dorothea Wagner, and Karsten Weihe</i> ..... | 343 |
| Robot Mapping: Foot-Prints vs Tokens<br><i>Xiaotie Deng and Andy Mirzaian</i> .....  | 353 |

## SESSION 9 Invited Paper

|   |     |
|---|-----|
| Recent Developments in the Approximability of Combinatorial Problems<br><i>Mihalis Yannakakis</i> ..... | 363 |
|---|-----|

## SESSION 10A

|   |     |
|---|-----|
| On the Relationship among Cryptographic Physical Assumptions<br><i>Tatsuaki Okamoto</i> ..... | 369 |
|---|-----|

|   |     |
|---|-----|
| Separating Complexity Classes Related to Bounded Alternating w-Branching Programs<br><i>Christoph Meinel and Stephan Waack</i> .....                              | 379 |
| The Complexity of the Optimal Variable Ordering Problems of Shared Binary Decision Diagrams<br><i>Seiichiro Tani, Kiyoharu Hamaguchi, and Shuzo Yajima</i> .....  | 389 |
| On Horn Envelopes and Hypergraph Transversals<br><i>Dimitris Kavvadias, Christos H. Papadimitriou, and Martha Sideri</i> .....                                    | 399 |
| <b>SESSION 10B</b>  |     |
| Page Migration Algorithms Using Work Functions<br><i>Marek Chrobak, Lawrence L. Larmore, Nick Reingold, and Jeffery Westbrook</i> .....                           | 406 |
| Memory Paging for Connectivity and Path Problems in Graphs<br><i>Esteban Feuerstein and Alberto Marchetti-Spaccamela</i> .....                                    | 416 |
| Randomized Competitive Algorithms for Successful and Unsuccessful Search on Self-Adjusting Linear Lists<br><i>Lucas Chi Kwong Hui and Charles U. Martel</i> ..... | 426 |
| Randomized On-Line Algorithms for the Page Replication Problem<br><i>Hisashi Koga</i> .....   | 436 |
| <b>SESSION 11A</b>  |     |
| New Algorithms for Minimizing the Longest Wire Length during Circuit Compaction<br><i>Susanne E. Hambrusch and Hung-Yi Tony Tu</i> .....                          | 446 |
| Parallel Algorithms for Single-Layer Channel Routing<br><i>Ronald I. Greenberg, Shih-Chuan Hung, and Jau-Der Shih</i> .....                                       | 456 |
| <b>SESSION 11B</b>  |     |
| Consecutive Interval Query and Dynamic Programming on Intervals<br><i>Alok Aggarwal and Takeshi Tokuyama</i> .....  | 466 |
| An Improved Algorithm for the Traveler's Problem<br><i>Alok Aggarwal and Takeshi Tokuyama</i> .....   | 476 |
| <b>SESSION 12A</b>  |     |
| Vehicle Scheduling on a Tree with Release and Handling Times<br><i>Yoshiyuki Karuno, Hiroshi Nagamochi, and Toshihide Ibaraki</i> .....                           | 486 |
| Scheduling Algorithms for a Chain-like Task System<br><i>Chan Chi Lok and Gilbert Young</i> .....   | 496 |

|   |     |
|---|-----|
| Weighted Independent Perfect Domination on Cocomparability Graphs<br><i>Gerard J. Chang, C. Pandu Rangan, and Satyan R. Coorg</i> ..... | 506 |
|---|-----|

## SESSION 12B

|   |     |
|---|-----|
| Plane Sweep Algorithms for the Polygonal Approximation Problems with Ap-<br>plications<br><i>D.P. Wang, N.F. Huang, H.S. Chao, and R.C.T. Lee</i> ..... | 515 |
| Optimal Rectilinear Steiner Tree for Extremal Point Sets<br><i>Siu-Wing Cheng, Andrew Lim, and Ching-Ting Wu</i> .....                                  | 523 |
| Faster Approximation Algorithms for the Rectilinear Steiner Tree Problem<br><i>Ulrich Fößmeier, Michael Kaufmann, and Alexander Zelikovsky</i> .....    | 533 |